

REPORT DOCUMENTATION PAGE					Form Approved OMB No. 0704-0188	
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1. REPORT DATE (DD-MM-YYYY) 07-03-2012		2. REPORT TYPE Master of Military Studies			3. DATES COVERED (From - To) September 2011 - March 2012	
4. TITLE AND SUBTITLE U.S. Navy Littoral Combat Ship: Current Issues and How to Deploy It in the Future				5a. CONTRACT NUMBER N/A		
				5b. GRANT NUMBER N/A		
				5c. PROGRAM ELEMENT NUMBER N/A		
				5d. PROJECT NUMBER N/A		
6. AUTHOR(S) Lieutenant Commander Gregory M Zimmerman, United States Navy				5e. TASK NUMBER N/A		
				5f. WORK UNIT NUMBER N/A		
				8. PERFORMING ORGANIZATION REPORT NUMBER N/A		
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) USMC Command and Staff College Marine Corps University 2076 South Street Quantico, VA 22134-5068				10. SPONSOR/MONITOR'S ACRONYM(S) N/A		
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES) N/A				11. SPONSOR/MONITOR'S REPORT NUMBER(S) N/A		
				12. DISTRIBUTION/AVAILABILITY STATEMENT Unlimited		
13. SUPPLEMENTARY NOTES N/A						
14. ABSTRACT <p>The Littoral Combat Ship (LCS) faces issues from budget cuts and overworked crews to behind-schedule mission modules with unproven technology. Built to low survivability standards and minimally manned, the LCS is not intended to operate in hostile environments, yet its mission sets constitute ASW, SUW, and MIW, which would occur in a medium to high threat environment. Mission Modules are behind schedule and are using unproven technology. The SUW mission module currently has no missiles, the ASW package was scrapped for an entirely new one that is in development, and the MIW mission lacks both remote vessels and the airborne mine detection system. Currently LCS is manned with two "core" crews, "blue" and "gold", which rotate every 40 days. This is supposed to alleviate the overburdened and stressed crewmembers who must work more hours than a "typical" sailor. The Navy announced plans to base four LCS ships in Singapore by 2016 and rework the ship manning so there are three crews assigned to two ships on a rotational basis flying to and from the U.S. Forward basing of LCS could be the answer.</p>						
15. SUBJECT TERMS						
16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT UU	18. NUMBER OF PAGES 53	19a. NAME OF RESPONSIBLE PERSON Marine Corps University/Command and Staff College	
a. REPORT Unclass	b. ABSTRACT Unclass	c. THIS PAGE Unclass			19b. TELEPHONE NUMBER (Include area code) (703) 784-3330 (Admin Office)	

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Command and Staff College
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MASTER OF MILITARY STUDIES

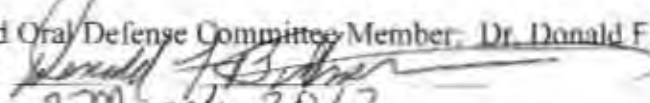
**TITLE: U.S. Navy Littoral Combat Ship:
Current Issues and How to Employ It in the Future**

SUBMITTED IN PARTIAL FULFILLMENT
OF THE REQUIREMENTS FOR THE DEGREE OF
MASTER OF MILITARY STUDIES

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Executive Summary

Title: The U.S. Navy Littoral Combat Ship: Current Issues and How to Employ it in the Future

Author: Lieutenant Commander Gregory Zimmerman, United States Navy

Thesis: The Littoral Combat Ship (LCS) faces issues from budget cuts and overworked crews to behind-schedule mission modules with unproven technology. Built to low survivability standards and minimally manned, the LCS is not intended to operate in hostile environments.

Discussion: The LCS is designed to be an affordable, minimally manned, mission flexible platform for operations in the littoral environment. 55 were supposed to be built and currently 20 are funded (17 in the next five years): ten *Freedom* class and ten *Independence* class ships. The original concept of packs of multiple LCS ships in a surface action group, each configured for various missions, is quickly evaporating. Built to the same low “Level I” survivability of an auxiliary or cargo ship, the LCS is not designed to operate in a medium to high threat environment. Despite this, its mission sets constitute ASW, SUW, and MIW, which would occur in a medium to high threat environment. Mission Modules are behind schedule and are using unproven technology that increases risk to the program. The SUW mission module currently has no missiles, the ASW package was scrapped for an entirely new one that is in development, and the MIW mission lacks both remote vessels and the airborne mine detection system.

How to deploy and employ the LCS is still to be determined. The most recent development as of this writing, was on February 15, 2012, Navy Secretary Ray Mabus said the Navy plans to base four LCS ships in Singapore by 2016 and rework the ship manning so there are three crews assigned to two ships on a rotational basis flying to and from the U.S.

Manning is critical to the LCS. Currently LCS is manned with two “core” crews, “blue” and “gold”, which rotate every 40 days. This is supposed to alleviate the overburdened and stressed crewmembers who must work more hours than a “typical” sailor. With manpower being the highest cost in the military, The LCS was sold on the basis of needing only 40 personnel in the crew. The first operational LCS deployment and joint exercise (RIMPAC 2010) consisted of a crew approaching 100, and with two crews, that number is nearing 200 to operate one LCS.

With build numbers that suggest LCS will probably deploy without other LCS ships for mutual support, an alternate means of employment would be deploying LCS with another surface combatant such as a destroyer or cruiser in a medium to high threat environment. That would greatly increase each ship’s mission effectiveness using mutual support. Without support, LCS should deploy independently in low-threat environments such as conducting counter-drug or Maritime Interdiction Operations.

Conclusion: With limited numbers of LCS ships ready for deployment and mission modules that are late in development, deployments needs to be carefully examined as well as future employment tactics. In the near future, LCS should either deploy independently in support of operations in low threat environments, or team up with a cruiser/destroyer to handle medium to high threat environments in the littorals.

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PREFACE

I chose to study the LCS for two reasons. The first being that I am a Light Airborne Multi-Purpose System (LAMPS) MK-III SH-60B helicopter pilot, and the LCS is a future LAMPS air capable platform from which the newer MH-60R, MH-60S and Fire Scout UAV will operate. Secondly, because the U.S. Navy had committed significant funding and manpower towards the program in a fiscally constrained environment with impending budget, personnel, and equipment cuts on the horizon, I wanted to research the LCS and learn why the Navy is investing so much into this program.

I have deployed as a LAMPS pilot on the *Oliver Hazard Perry* class frigate USS *Crommelin* (FFG-37) in 2000, the *Spruance* class destroyer USS *Fletcher* (DD-992) in 2003, and as the Airboss and Officer-in-Charge of the air detachment again on the USS *Crommelin* (FFG-37) in 2009. I have also operated from all the other air capable ships in the fleet: *Nimitz* class carriers (CVN), amphibious carriers (LHA/LHD), Aegis cruisers (CG), and guided missile destroyers (DDG flight I and II).

It was exciting to be researching a current program in which headlines were being made literally as I was typing the paper. During the revision process of this paper, the latest headlines included the announcement of stationing four LCS ships to Singapore by 2016 with three crews per pair of ships, DoD sliding two LCS ships from the Five-Year Defense Program (FYDP), the firing of the LCS Program Manager, and the USS *Freedom* (LCS-1) blew a port shaft seal in which she suffered minor flooding while underway, limped back to port, and is in dry dock. Research was difficult and somewhat limited. Libraries do not yet have much information on LCS, so I was limited to Internet research. The best sources of information were Naval journals, Government Accountability Reports, Congressional Research Service reports, and Navy and

Contractor websites.

My attempts to contact and interview actual sailors from the LCS ships went unanswered. I can only speculate that they are busy, tired of answering questions for everyone else's research and reporting, or maybe cautioned not to talk about the LCS to outsiders. I did get a golden nugget though using my aviation contacts to get in contact with LCDR Jeffery Sowers and LCDR Roy Zaletski, both of them were Officers in Charge (OIC) of the HSC-22 aircraft detachments (blue and gold respectively) on USS *Freedom*'s maiden deployment. Reading through their Lesson's Learned and correspondence via email, I gained pertinent information and insight. Who knew there were no soda machines on an LCS ship?

My sincerest thanks goes to Dr. Donald F. Bittner for his mentoring through the MMS process and my wife, Delicia, for handling our child Jack while I typed and researched for many weeks and months.

LCS is Taking Over the Fleet and the World!

“55 of the future 285-ship Navy will be LCS”

“4 LCS ships will be stationed in Singapore by 2016”

“The Navy Avoids Deep Budget Cuts”

“17 LCS ships to be built in the next five years”

HISTORICAL: STREETFIGHTER

The concept of the modern Littoral Combat Ship started with the introduction of the “Streetfighter Concept” published in a November 1999 *Proceedings* article “Rebalancing the Fleet”. The concept was a fast ship with offensive firepower, armed helicopters, and modular adaptability to be configured for the specific mission at hand.¹ The ship would take the fight to the enemy’s home waters or “streets”, another term for the littoral environment from this came the term “Streetfighter”.² Streetfighter was to be an “Economy B force.” This meant that the cheaper, weaker, and more numerous streetfighter ships would be on the front lines while the greater “Economy A” combat power units (carriers, cruisers and destroyers) would provide converge similar to the way destroyers used to screen battleships.³ Putting the “Economy B” ships forward was reverse of the older tactic of using a “high-low” mix, in which the major combat power ships were on the front line, while the weaker and more expendable ships were assigned less demanding tasks.⁴

In 2000, Admiral Vern Clark became the Chief of Naval Operations (CNO) and ordered his staff to study the advantages and disadvantages of the Streetfighter concept.⁵ A year later, Donald Rumsfeld assumed office as the Secretary of Defense and his 2001 Quadrennial Defense Review (QDR) reviewed every Department of Defense (DoD) program. That QDR resulted in the cancellation of the Navy’s DD-21 future combat ship program and replaced it with the Future Surface Combatant Program. The new initiative consisted of the future Destroyer DD(X) (now called DD1000), Cruiser CG(X), and Littoral Combat Ship (LCS).⁶ The DD1000 *Zumwalt* class destroyer will be a next-generation ship providing air defense and naval gunfire support. Two ships are currently contracted and being built. The DD1000 is schedule to be delivered in FY14 with Initial Operating Capability in FY2016. DDG 1001 is about 20% complete as of July

2011.⁷

The move from the Cold War era “blue water” Navy to a littoral “brown water” Navy has thus been a slow and continual process. A long line of strategy papers reflect this including: *Maritime Strategy* (1986), littoral emphasis in ...*From the Sea* (1992), *and Forward...from the Sea* (1994), and finally *Sea Power 21* (2002). All of these have called for the increase in power projection and dominance of the littoral environment. *Sea Power 21*, being a post-9/11 era document, called for the “transformation for a violent era.” It had three tenets: “Sea Shield”, “Sea Strike”, and “Sea Basing”. “Sea Shield” called for sea/littoral superiority and homeland defense, specifically demanding “Mission-reconfigurable Littoral Combat Ships” and “manned and unmanned aviation assets” to gain and maintain the operational advantage.⁸

LCS IS BORN

The LCS program office was established in February 2002. This program office in conjunction with the Navy’s Assessment Department (N81), Office of State Department (OSD)’s Program Analysis and Evaluation (PA&E), Naval Sea Systems Command (NAVSEA), and a study team at the Naval War College, all worked towards ascertaining what the LCS design should encompass. All of the analysis came to nearly the same conclusions: that the LCS would be a corvette, meaning a small, maneuverable, and lightly armed warship. Other requirements included having helicopters, mission specific modules, trans-oceanic endurance, and an optimal top speed of 40-50 knots.⁹

On May 27, 2004, the Navy awarded contracts to two industry teams, Lockheed Martin (LM) and General Dynamics (GD), to design their own competitive versions of the LCS.¹⁰ The Lockheed Martin Corporation team included Maritime Systems & Sensors in Moorestown, NJ and Marinette Marine in Marinette, WI.¹¹ The General Dynamics team included Bath Iron

Works, Bath, MN and Austal of Mobile, AL.¹² Originally, both companies were building their own versions of the LCS to compete against each other and the Navy would select the winner for production, called a down select. Instead, after the competition, the Navy chose to buy both versions in a dual-award contract. This is discussed further in the “Budget Issues” chapter.

MEET THE LCS

The Littoral Combat Ship (LCS) is the newest class of ship in the U.S. Navy. Designed to dominate in the littoral environment, it is a small, fast, shallow water capable, network-centric, minimally manned, affordable ship. It relies on manned and unmanned vehicles, and utilizing swappable mission modules to execute its assigned missions. The LCS eventually spawned into two distinct classes the *Freedom* class (LCS-1) and the *Independence* class (LCS-2).

Lockheed-Martin’s *Freedom* class is a traditionally shaped, high-speed semi-planing monohull (illustration Appendix C). General Dynamics’ *Independence* class is a non-conventional trimaran hull design (illustration Appendix D) based on the Benchjigua Express passenger/car ferry.¹³ While the two classes look very different, they possess many similarities. Both classes use a combination of two diesels and two marine gas turbines powering four water jets enabling 40+ knot sprints. The water jets allow for high speed and very shallow water operations. The ships can operate aircraft in conditions up to Sea State 5, have hangar space for two SH-60 helicopters or six Fire Scout UAVs, and have similar drafts (*Freedom* 12.8 feet/*Independence* 14.1 feet).¹⁴ Launching and recovering watercraft from *Freedom* can be done from either her side or stern, while *Independence* uses her twin-boom expandable crane from the stern only.¹⁵

Their significant difference is in size; while *Freedom* is 378 feet long with a 57.4-foot beam, *Independence* is 416.9 feet in length and nearly doubles the width with a 103.7-foot

beam. *Independence*'s additional beam makes for a flight deck nearly three times the size of any other surface combatant and she can operate two SH-60 helicopters simultaneously, multiple Unmanned Aerial Vehicles (UAV), or a helicopter of H-53 size.¹⁶ *Independence* also has the unique capability due to her greater internal payload volume to carry a back up mission module and switch them at sea utilizing her internal platform elevator and cargo handling equipment.¹⁷ Even their hull materials differ: *Freedom* is built with a steel hull and aluminum superstructure, while *Independence* is built entirely from aluminum.¹⁸

Permanent armament (always equipped, regardless of mission configuration) for both classes include the BAE Systems MK110 57mm naval gun system with its 220 rounds-per-minute rate of fire with six shooting modes; this includes an air-burst for defense against small attack.¹⁹ Anti-missile defense is by Rolling Airframe Missiles (RAM) on both classes. *Freedom* utilizes a SeaRAM 11-shot launcher, and *Independence* uses a 21-missile launcher.²⁰ *Freedom*'s decoy system is the Soft-Kill Weapon System (SKWS) decoy launcher from Denmark.²¹ *Independence* uses three Super Rapid-Bloom Off-Shore Countermeasures (SRBOC), and two Nulca decoy launchers.²²

MISSIONS AND MODULES

Primary missions of the LCS are Anti-Surface Warfare (SUW), Anti-Submarine Warfare (ASW), and Mine Warfare (MIW). There are three important definitions when addressing mission modules with the LCS: Mission Systems are vehicles, sensors, and weapons; Mission Modules are the mission systems plus support equipment; and Mission Packages (MP) are the Mission Modules, Mission Crew Detachments, and Aircraft.²³ The LCS Mission Package Support Facility (MPSF), located in Naval Base Ventura County, California, will support all LCS Mission Modules.²⁴ The MPSF will maintain and provide technical support afloat for

Mission Module Sailors. The Mission Systems fit inside standard ten or twenty feet long International Organization For Standardization (ISO) shipping containers.²⁵ Aircraft are a major part of the MP's and are discussed in their own section with what they bring to each mission area.

ANTI-SURFACE WARFARE

The LCS SUW mission and associated MP are designed for fleet protection from small boats and other asymmetric threats. The SUW package can also be tailored for interdiction missions against terrorist suspects, pirates, and defense against shore attacks when operating in the littoral environment.²⁶ The key components are the Gun Mission Module(s), Missile Launch Module, MH-60R helicopter, UAV (Fire Scout), Mission Package Application Software Module, and the optional Maritime Security Module.

The MK 50 Gun Mission Module consists of the MK 46 30mm gun weapon system, 400 rounds of ammunition in the turret, and two ready service magazines with 240 rounds each.²⁷ LCS can carry two such gun modules. The 30mm is intended for high-density fire at closer range (2,200 yards maximum effective range)²⁸ than the organic 57mm gun (maximum effective range not available). The 30mm is tasked to counter the Fast Attack Craft (FAC)/Fast Inshore Attack Craft (FIAC) threat in which numerous fast speedboats “swarm” at a naval vessel. The 57mm, 30mm, and crew served .50 caliber Browning M2 machine guns allow for a triple layer of overlapping defense.

The missile module was originally going to use the Army missile program, Non-Line of Sight Launch System (NLOS-LS), which was cancelled in May 2010 on the recommendations of the U.S. Army. On January 11, 2011, the Navy announced that the Griffin missile was the recommended replacement for NLOS-LS and it would be half the cost and delivered in the same

time frame that was promised in the NLOS-LS program. The Navy has said the Griffin would be ready by 2014 or 2015, with a follow on version ready by 2016-2017. Concern has risen, however, in the much shorter range of the Raytheon built Griffin compared to the NLOS-LS. While the exact range has not been officially disclosed, industry experts have reported it to be approximately 3.5 miles when surface-launched. In a press report dated April 18, 2011, Under Secretary of the Navy Robert Work cited Raytheon and stated the missile would have a range of about 3.1 miles. This was a huge reduction in range and capability from the NLOS-LS that was estimated to have an estimated range of 25 miles.²⁹ Having an offensive missile range of only around 3.5 miles is a severe limitation to LCS's offensive and defensive capabilities and will do little to counter its already weak survivability.

LCS can be configured for missions requiring Visit, Board, Search, and Seizure (VBSS) teams such as Maritime Interdiction Operations, Counter-Drug, and Anti-Piracy. The Maritime Security Module, which is part of the Anti-Surface Warfare MP, includes two 11-meter Rigid Hull Inflatable Boats (RHIBs), berthing module, and VBSS equipment module.³⁰ VBSS teams can use the 11m RHIBs to board both compliant and non-compliant vessels. (For illustration and specifications of the 11-meter RHIB, see Annex H.)

ANTI-SUBMARINE WARFARE

The LCS equipped with the ASW Mission Package is designed to provide "Joint Force Commanders with the capability to conduct detect-to-engage operations against modern diesel-electric and nuclear submarines in littoral areas, and defeat those that pose an immediate threat."³¹ ASW roles for the LCS include protecting forces in transit (escort duty), protecting joint operating areas, and establishing ASW barriers (screening) that are effective in both shallow littoral and deep waters.

However, there have been major setbacks in the ASW program. The Advanced Deployable System (ADS) had been the center of the ASW module and was intended to be a fast-deploying underwater sensor net, however it was cancelled in 2007.³² The next mainstay was expected to be Lockheed's WLD-1 Unmanned Sub-surface Vehicle (USV) towing the AN/AQS-20A sonar, but it was relegated to mine warfare only in 2009.³³ What USV the Navy is currently testing for the ASW MP is unavailable in open source information. Nonetheless, speculation postulates that the Spartan Unmanned Surface Vehicle (USV) with its organic acoustic systems would increase the range for ASW operations. The Spartan is a remote controlled 7 or 11 meter RHIB that can be equipped with sensors.³⁴ While the current status of the ASW program equipment cannot be found in open source, in a January 14, 2011 press report the Navy said "...while the ASW module was able to do the mission, the equipment package proved unsatisfactory because the ship would actually have to stop in the water to deploy the equipment."³⁵

A second generation (Spiral BRAVO) ASW MP is under development for delivery in 2016 or 2017, of which the Navy plans to purchase 16. This means that in spiral development continuous improvements are being applied and tested. It is planned to include in the ASW MP an ASW Escort Module, Torpedo Defense Module (TDM), Aviation Module, and ASW Mission Management/C2 Center. The Escort Module has a Variable Depth Sonar (VDS), Multi-function Towed Array (MFTA) acoustic receiver, and support equipment. The TDM adds countermeasures called the Light Weight Tow (LWT). The Aviation Module will be covered in a follow on section, and the Mission Management/C2 Center will be the application software that interfaces with the ship's open architecture computer system.³⁶

LCS lacks the MK32 torpedo launchers that other U.S. Navy combatants are armed with.

Having a torpedo launcher on the ship allows for a rapid response to counter or deter an attack from a submarine. An LCS can only deploy a torpedo if its MH-60R helicopter fires it. If a submarine is near enough to attack and the helicopter was not already airborne with its ordnance loaded, the ship would be vulnerable as it takes at least an hour to launch a helicopter that is stowed in its hangar.³⁷

MINE WARFARE

The LCS in the Mine Warfare (MIW) mission is designed to revolutionize the way the Navy clears an operating area. Unlike the current *Avenger* Class Mine Sweeper that needs to be in a minefield to detect the weapons, the LCS will utilize aircraft and remote controlled mine sweep vessels to detect and neutralize mines while the ship is safely outside the danger area. The MIW technology is still evolving and not fully operational to date. The MIW MP includes equipping the helicopter with mine detection and neutralization gear and fielding the Remote Multi-Mission Vehicle (RMMV). The Navy plans to procure 24 MIW MPs.

The Airborne Laser Mine Detection System (ALMDS) built by Northrop Grumman, uses directed energy (LASER) to detect, classify, and localize floating and near surface moored mines.³⁸ It is physically attached to the SH-60R or SH-60S helicopter's BRU-14 bomb rack. There are two issues with mine sweeping aircraft: If the helicopter has an emergency and has to ditch, how is the crew going to be rescued in a minefield? The second issue is that if the minefields are in a contested area and covered by fire, helicopters have limited defenses in such an environment.

Problems are prevalent with the ASW MP. A 2010 Government Accountability Office (GAO) reported on many issues with the MIW mission kit. Specifically in regards to ALMDS, "testing of this system has revealed problems detecting mines at the required maximum depth

and classifying mines at surface depths...the system is currently incapable of providing this capability with the required accuracy.”³⁹ Another setback was with Northrop Grumman’s Rapid Airborne Mine Clearance System (RAMICS). RAMICS used a “gated electro-optic Laser Imaging Detection and Ranging sensor for target re-acquisition and 30mm MK44 Bushmaster II gun for neutralization. The gun used a MK 258 Mod 1 armor-piercing, fin stabilized tracer round which is stable during flight, and after penetrating the water, supercavitates to greatly reduce drag and improved underwater flight performance.”⁴⁰ This program was cancelled in May 2011 for reasons not available in open source.⁴¹

The Navy is getting positive results so far with the RMMV, which is an unmanned, semi-submersible, semi-autonomous vehicle that will use the towed AN/AQS-20A mine hunting sonar system to conduct mine reconnaissance for bottom and moored mines in deep to very shallow water. Up to two RMMVs can be controlled from the LCS. This seven meter, diesel powered vessel drives at speeds exceeding 16 knots. The snorkel and mast are the vehicle’s only visible feature above the water. The RMMV can operate for greater than 24 hours, and if recovery is not possible, it can “sleep” until it receives new instructions.⁴² On December 19, 2011, the RMMV completed 500 hours of reliability testing marking a critical testing milestone.⁴³

AVIATION

LCS has the capability to deploy with MH-60S and MH-60R Seahawk helicopters as well as the MQ-8B Sea Scout UAV. Unlike the Mission Modules, which are still in development, the MH-60S and MH-60R helicopters are fully operational and currently employed on aviation capable Navy ships. The MH-60S and MH-60R share a common cockpit, but their airframes and mission systems are very different. The 60S lacks radar and ASW capability, but has a much higher cargo and personnel capacity; for example, it can carry up to 20 armed troops. The 60R is

heavily laden with mission equipment, ASW suite and surface radar, but has space for only two passengers.

The MH-60S is a multi-mission helicopter that is a hybrid of a H-60 Seahawk and UH-60L Army Blackhawk. By adapting the Blackhawk's aft tail wheel configuration, the MH-60S gained cabin space and has cabin doors on both sides of the airframe. Crew served weapons can be mounted in both doors giving the MH-60S an advantage over the MH-60R's single door mounted weapon. The MH-60S was designed as a replacement for the Navy's CH-46D Sea Knight heavy-lift tandem rotor helicopter.⁴⁴ In 2007 Lockheed Martin integrated armed helicopter kits into the 60S giving it the same FLIR/Hellfire missile system the SH-60B has and thereby allowing it to also replace the HH-60H Combat, Search and Rescue (CSAR) helicopter.⁴⁵ The MH-60S Block IIIB adds the FLIR/hellfire system and Link 16 data link. The first MH-60S Block IIIB armed helicopter expeditionary detachment was embarked on USS *Freedom's* first deployment.

The MH-60R Light Airborne Multipurpose System (LAMPS) is a multi-mission maritime aircraft that conducts ASW and SUW as its primary missions. Secondary missions include Search and Rescue (SAR), Vertical Replenishment (VERTREP), Naval Gunfire Support (NGFS), and Communications Relay (COMREL). The MH-60R is also the newest helicopter in the Navy, replacing the SH-60B and SH-60F models.⁴⁶

For the SUW mission, the MH-60R is equipped with a powerful Inverse-Synthetic Aperture Radar (ISAR) that can show the shape of a target based on its RADAR signature. It features a Raytheon AN/AAS-44 Forward-Looking Infrared (FLIR) turret for identifying contacts as well as incorporating a laser rangefinder and designator for the hellfire missile system, of which it can carry up to four AGM-114 missiles. A crew served weapon mount in the

cabin door can be armed with the M-240 7.62mm or GAU-16 .50 caliber machine gun. The Electronic Surveillance Measures (ESM) suite allows the MH-60R to “see” other radars and emitters. For self-defense, the MH-60R has the AN/AAR-47 missile detector, laser warning system, ALQ-144 Infrared Jammer, and AN/ALE-39 chaff and flare dispenser.⁴⁷

In the ASW role, the MH-60R carries the Raytheon AN/AQS-22 Advanced Airborne low-frequency (ALFS) dipping sonar as well having a launcher for sonobuoys. Weapons include the ability to carry up to three MK-46, MK-50, and future MK-54 airborne light torpedoes. Critical to the MH-60R is its secure datalink that feeds all of its sensor data: radar, FLIR imagery, sonobuoy/sonar acoustic data, ESM, helicopter location, and even voice to whatever ship in which it is in link. This allows a small team of operators in the ship’s Combat Information Center (CIC) to greatly increase mission effectiveness of the entire LAMPS team.⁴⁸

The Northrop Grumman MQ-8B Fire Scout is a rotary wing vertical take-off and landing UAV that can autonomously operate from aviation-capable warships and landing zones.⁴⁹ (See appendix G for illustration and specifications). Fire Scout is based on the Schweizer 333 helicopter that has an established commercial track record. Fire Scout’s endurance is eight hours, which allows operations at a range of 110 miles from the ship with six hours of on station time.⁵⁰ Sensors include maritime radar, Tactical Common Data Link (TCOL), FLIR with Electro-Optical (EO) sensing, and a laser target designator/rangefinder.⁵¹ Three Fire Scouts can fit in the same footprint as one H-60 helicopter. A surface combatant typically has hangar space for two H-60 helicopters, thereby giving the options for two helicopters, one helicopter and up to three UAVs, or six UAVs. Fire Scout completed its first operational deployment on the frigate USS *Halyburton* (FFG 40) in June 2011, flying 435 hours with an 80% sortie completion rate.⁵² Fire Scout was involved in three anti-piracy actions, participated in operations over Libya, and

supported a Strait of Hormuz transit with the ship's SH-60B helicopter.⁵³ The Navy plans to eventually purchase 168 MQ-8B Fire Scout UAVs.⁵⁴

Helicopter Maritime Strike Squadron 35 (HSM-35) will stand up July 1, 2012, and be the first composite squadron to fly both the MH-60R and MQ-8B.⁵⁵ HSM-35, the "Magicians", should be a fully operational squadron by summer of 2013.⁵⁶ It has not been determined exactly who will be cross trained to operate and fly the Fire Scout, but options range from the helicopter pilots to specially trained enlisted sailors. There will also be additional maintenance training for the MH-60R mechanics to learn and be certified to work on the MQ-8B. The advantage of the composite squadron is that it will negate the current requirement to have additional MQ-8B operators and mechanics onboard when fielding the system onboard a ship. The squadron would have the flexibility to deploy any mix of MH-60R and MQ-8Bs as the mission requirements and/or aircraft availability dictate.

ISSUES AFFECTING LCS

MANNING

LCS is manned with the submarine model of "blue" and "gold" teams, meaning there are two full crews for each ship. An LCS sailor typically works more hours than a sailor on any other class of ship because the small crew size. They are also trained to do many jobs in which the Navy is calling them "hybrid sailors".⁵⁷ The workload is so high for the typical LCS sailor that the current plan is for the crews to swap out every 40 days. Open source details are extremely scarce, but the typical crew is planned to be 40 to run the seaframe, plus additional sailors and airmen as required for the appropriate mission packages. Automation is the answer for the low manning numbers, as most of the ship's systems are computer controlled and watched via cameras. The extra workload becomes a factor in "special evolutions" such as

launching and recovering RHIBs, aircraft, and taking on supplies and fuel while underway. Crewmembers have more work to do than on regular Navy ships, from the Captain and Executive Officer helping to clean the ship, to all hands buss and wash their own dishes after a meal and sailors do their own laundry.⁵⁸

No sailor under the rank of E-5 gets orders to an LCS ship.⁵⁹ It takes months to pass a lengthy training program ashore to become an LCS crewmember. One example was Combat Systems Officer LCDR Timmons, who said it took 22 months of training before reporting to USS *Freedom*. In an interview to National Defense Magazine, he said that he gets four to six hours of sleep every 24 to 48 hours, and that the workload is grueling, but manageable.⁶⁰

On USS *Freedom's* maiden deployment in 2010, she sailed with 40 sailors for the seaframe (core crew) and about 50 additional sailors (Navy and Coast Guard) aboard to support aviation operations, the surface warfare module, and boarding and inspection teams.⁶¹ To accommodate the additional personnel, *Freedom* embarked berthing modules placed in her mission bay to provide bunks and personal stowage.⁶² Berthing modules do not contain toilet or shower facilities, thus berthing module sailors have to share bathrooms (called “Heads” in the Navy) with the ship’s crew.

In a February 15, 2012 Washington Post article, Secretary of the Navy Ray Maybus was reported as saying that four LCS ships will be stationed in Singapore by 2016. Mr. Maybus also said those ships will be manned at three crews for two ships, on a rotational basis, flying back and forth from the U.S.⁶³ This is an interesting concept as it reduces what would have been eight forward deployed crews to six home ported in the U.S.

LCS also suffers from “quality of life” issues that do not affect other ships. LCS has no ship’s store (called a geedunk) or vending machines.⁶⁴ Other than the standard three meals per

day and the midnight “midrats”, no extra food or drinks are available to the crew. This also means crews must bring their own comfort items, toiletries, and tobacco products as there are none for sale on the ships. Another quality issue is that LCS ships lack television. The Navy’s satellite TV, called Direct to Sailor (TV-DTS), is installed on most every other ship in the fleet, giving those sailors situational awareness of current events via NEWS, or just enjoying sports or shows. That is missing on LCS.

Water making is limited on LCS. The system is designed to support 60 sailors, but USS *Freedom*’s crew swelled to almost 100 personnel during RIMPAC 2010. This forced the ship to shut down its laundry on a number of occasions to conserve water.⁶⁵

Flight operations also had a significant impact with the ship’s manning. Both crews reported that sustained flight operations were extremely fatiguing. The core crews were in a three-shift rotation and had to spare one of the shifts to man critical stations for “flight quarters.” This included the aviation fire fighting party and the helicopter control station.⁶⁶ The only recommendations to fix the issue were to increase the manning of the core crew.⁶⁷ However, increasing the size of the core crew is not practical because LCS has a maximum capacity of 100 even with berthing modules installed and adding to the core would mean limiting manning for mission module or flight crews.⁶⁸

BUDGET ISSUES

The LCS program has been faced with fiscal challenges from its inception. The Navy plans to buy 55 LCS ships and 64 mission packages (16 ASW, 24 MCM, and 24 SUW).⁶⁹ DOD’s Selected Acquisition Report (SAR) for the LCS program released in mid-April 2011 estimates the total acquisition costs for the 55 LCS sea frames (not counting mission modules) at \$37.4 billion. The sea frames were supposed to cost \$220 million each in FY2005 dollars, but

that cost has subsequently more than doubled. In 2007, due to significant cost growths and delays in construction, the Navy cancelled four LCSs that were funded in FY2006-2007 and a fifth in 2008. On September 16, 2009, the Navy announced its planned acquisition strategy to pick a single LCS design, called a “down select”. However, the down select was not implemented and on November 3, 2010, the Navy instead opted for a dual-award acquisition strategy to purchase both. On December 29, 2010, the Navy implemented a 10-ship, fixed-price incentive (FPI) block-buy contract to Lockheed, and another 10-ship-buy to Austal USA.⁷⁰

In order to help control costs, the two contracts had an average unit cost of \$440 million with a cost cap of \$538 million. Any cost overruns above the total and up to ceiling cost would be shared between the contractor and the Navy, and any costs over the ceiling cap would fall completely on the contractor.⁷¹ This was an important measure as it put considerable pressure on the contractors to not exceed the cost cap without having to pay for it themselves. With the recently proposed \$263 billion reduction in defense spending, ship building will not get slashed according to Sean Stackley, the Navy’s top acquisition official.⁷²

As of April 2010, the Navy had contracted for 20 LCS ships, 10 of each type. 19 were budgeted during the five-year period FY2012-FY2016 in annual quantities of 4-4-4-4-3.⁷³ On February 13, 2012, President Barack Obama sent Congress a proposed defense budget for fiscal year 2013. In his proposed budget, the Navy remains committed to 55 LCS ships but procurement has been slowed across the Five-Year Defense Plan (FYDP). This would move two LCS ships out of the FYDP to future years. If the proposed FY-13 shipbuilding budget is approved, 17 LCS ships would be funded through the FYDP. The proposed budget also has reductions in purchasing MH-60R helicopters but the MQ-8B Fire Scout would be protected.⁷⁴ The annual LCS build numbers will not be known until the 2013 shipbuilding plan is released.

HULL CRACKING LCS-1

It was widely reported in the media that USS *Freedom* developed a six-inch crack through her hull during sea trials. This crack prompted a Navy investigation into the design.⁷⁵ Discovered below the waterline by sailors, the crack leaked five gallons of sea water an hour into the ship, which the commanding officer judged “manageable.”⁷⁶ The ship avoided rough seas and returned to its homeport in San Diego. The crack was due to a defective weld and was repaired. Other cracks that made the news were minor ones in the aluminum superstructure in identified high stress areas in which data collection instruments were installed to monitor. Those cracks appeared in the predicted areas and the Navy implemented design changes to the superstructure to correct and prevent them in future hulls.⁷⁷ Hull cracking is now considered a “non-issue” in the LCS class.

CORROSION LCS-2

Open source details are elusive on this topic. A *Bloomberg* article printed June 17, 2011 reported that Navy discovered aggressive corrosion on USS *Independence*.⁷⁸ The corrosion was due to dissimilar metals in salt water and affected her water jets. When two dissimilar metals, in this case steel and aluminum, are in close proximity in an electrolyte (saltwater) without protective measures in place, galvanic corrosion will result. A temporary fix was applied and a permanent fix will be applied sometime this year when *Independence* goes into dry dock for maintenance and will require the removal of her four water jets. Part of the permanent fix is the Impressed Current Cathodic Protection System (ICCP) that reduces the effects of galvanic corrosion in the cone assemblies and water jet tunnels of the *Independence* class ships.⁷⁹ This system will be applied to future ships of the class. Both the hull cracking and corrosion issues are “teething” issues inherent with any new class of ship, and will be rectified in follow on hulls.

TECHNICAL RISK

Another issue with LCS is the technical risk in developing and testing unproven technology in the mission packages while the seaframes are in full production and being deployed at sea. While LCS has successfully deployed, it has yet to field a complete mission package. On USS *Freedom*'s maiden deployment, she was outfitted a partial SUW mission package including two MK-46 30mm gun modules, VBSS teams, berthing modules, MH-60S helicopter and associated support equipment. Missing from the package was the offensive missile system as the Griffin was still in development and the NLOS-LS had previously cancelled. Since the deployment was a Fourth Fleet anti-drug mission, it was deemed acceptable to not have the missile module.⁸⁰

The next operational testing event involving a seaframe and partial mission package has been deferred to fiscal year 2013.⁸¹ The Navy expects individual mission package systems to remain in development through 2017.⁸² The ASW package is being delayed until the next generation modules can be tested. The MIW package had the most problems to date. Specifically, the Unmanned Surface Vehicle has not been demonstrated in a realistic environment.⁸³ The Remote Mine Hunting System also has been delayed because of poor reliability. Also, the RAMCS has been cancelled from the MIW package all together.

What are the ramifications of this? Until the mission packages can be tested, proven operational, and deployed, the LCS will have limited capabilities and need to have its near-future deployments tailored to match. The Navy still has yet to decide how it will move, store, and swap mission modules in theater. Open source information only reveals the plan to have the MPSF in Ventura, California. There is no mention of forward basing mission modules or how and where LCS ships will be reconfigured while deployed. One theory is using the Joint High

Speed Vessel (JHSV) as a mother ship, carrying mission modules and supplies for LCS, or carrying mission modules forward into theater.

JOINT HIGH SPEED VESSEL

The JHSV is a transport ship capable of high speed and shallow water operations. Made at the same Astral Shipyards that builds the *Independence* class LCS, it is a Small Water-plane Area Twin Hull (SWATH) design hull with jet propulsion. On Nov. 13, 2008, the Navy awarded Austal a \$185,433,564 fixed-price incentive contract modification for detail design and construction (DD&C) of one Joint High Speed Vessel (JHSV). The contract modification also included options for the construction of a maximum of nine additional ships and associated shore-based spares. Originally the Army and Navy were to have five each, but after the Army/Navy Warfighter Talks in December 2010, a memorandum was signed transferring all five of the Army's vessels to the Navy.⁸⁴ On February 24, 2012, the Navy exercised its options on the eighth and ninth JHSV awarding Austal USA \$321.7 million to build them. They are not scheduled for delivery until the summer of 2015 and winter of 2016.⁸⁵

JHSVs will be commissioned as United States Naval Ship (USNS) ships. This means they are non-commissioned auxiliary ships that are the property of the Navy. JHSV will have a civilian crew of 21 people, but will have airline style seating for more than 312 embarked forces and fixed berthing for 146. For self-defense, JHSV will be equipped with four, .50 caliber machine guns.⁸⁶

The Navy has said the JHSV, “does not require the survivability and ability to sustain damage like the LCS. It has no combat system capability and no ability to support or use LCS mission modules.” The JHSV is built to commercial ferry standards and not to warship standards, thereby making the ship highly vulnerable if it takes damage.⁸⁷ The JHSV is not a

viable option to support LCS for many reasons: it cannot carry mission modules, it is manned by civilians, has no combat systems capabilities and has a very limited on self defense capability.⁸⁸

SURVIVABILITY

Another issue with LCS is that the Navy designated it to only meet Level I survivability standards. According to the Office of the Chief of Naval Operations Instruction 9070.1 of September 23, 1988, (survivability policy) Navy ships are defined by three levels, I, II, and III. These levels of survivability provide a basis for establishing survivability performance standards. Level I ships are the least protected ships and are not designed to maintain their mission capabilities after incurring substantive damage. They are “expected to operate in the least severe environment, away from the area where a carrier group is operating or the general war-at-sea region.”⁸⁹ Examples of Level I ships are sealift, material support ships, and mine sweepers. Level II ships are more hardened and designed to operative with a battle group such as logistics support ships, frigates, and amphibious warfare ships. Level III is the highest level of survivability. These vessels are aircraft carriers and major surface combatants. The Navy is calling the LCS a “Level I+”. This hybrid designation results from adding Electro-Magnetic Pulse (EMP) hardening, Chemical, Biological, Radiological (CBR) protection with decontamination stations, shock hardening of damage control and propulsion systems, redundant automated firefighting systems, select fragmentation armor, and the ability to survive in up to Sea State 8.⁹⁰

In a March 9, 2011 hearing before House Appropriations Committee Defense Subcommittee, Representative James Moran (Dem., VA) questioned then CNO Admiral Gary Roughhead on the decision to build LCS to only Level I. Mr. Moran quoted a DoD Department of Operational Test and Evaluations (DOT&E) report saying, “The LCS design is not required to

include survivability features necessary to conduct sustained operations in the combat environment.” Congressman Moran then asked, “...why are we buying 55 of these surface combatants if they’re not designed to survive in a hostile combat environment? I don’t understand how we can justify that...” In response to this query, Admiral Roughhead replied, “...[LCS] still possesses levels of survivability and redundancy that allow it to go into hostile environments.”⁹¹

The Navy’s Concept of Operations (CONOP) brief dated April 29, 2011, lists how LCS should be employed to survive hostile threats. These include operating independently only in low to medium threat scenarios, and being part of a networked battle force in high threat environments. The CONOP further says that the LCS’s best defense is thus avoiding being hit in the first place.⁹² To accomplish this, tactics include using its 40+ knots of sprint speed combined with active and passive defenses such as RAM and Chaff. If the LCS is hit, it is designed to still remain afloat, mobile, and depart the threat environment, however, it is not to fight. Thus a hit effectively gives the enemy a mission kill.

To date, LCS has not gone through shock trials. “Shock trials are a congressionally mandated Live Fire Test and Evaluation Program that requires realistic survivability testing of each new class of Navy ships.”⁹³ The results from a shock trial provide important information that is applied to follow-on ships in the class. Typically the first ship in class is not tested, but one of the first follow-on ships is. In the March 9, 2011 hearing mentioned above, Representative Hank Johnson (Dem, GA) was concerned with, “unresolved questions regarding survivability of the LCS” and if it would meet its Level I requirements. He further questioned why the Navy was not scheduling shock trials on LCS until 2014, which by then 10 to 12 ships will already have been built. Assistant Secretary of the Navy for Research and Development and

Acquisition Sean Stackley answered that shock trails scheduled in 2014 “...is about right compared to all other shipbuilding programs.” Stackley added an example: the DDG-51 class destroyer, DDG-53 was the first ship shocked two years after 20 DDGs were under contract and in full rate production.⁹⁴

There are serious contradictions between the LCS’s mission and its survivability. Commanders will not be able to fully employ LCS as just another combat vessel. **Due to its inherent weaknesses, tactics will have to be tested and employed to ensure LCS is effective.** The tactic and concept originally put forth for several LCS ships to work together for mutual support with a mix of mission packages in the group might work in theory, but thus has yet to be tried or tested. With only 20 LCS ships currently funded (17 in the 5 year FYDP), that leaves ten on the West Coast and ten on the East Coast. Navy ships rotate between deployment and maintenance yard periods. Even with the basing of four LCS ships in Singapore, is it not likely that all would be deployed in the same place and time based on crew rotations, maintenance, and training schedules.

EMPLOYMENT RECOMMENDATIONS

In the near future, there will be up to 20 LCS platforms operating in the Navy with partial or no mission modules. Until LCS is fully mission-capable with operational mission modules, LCS is the prime candidate for assuming the *Oliver Hazard Perry* (OHP) class FFG frigate’s missions as the OHP’s are steadily being decommissioned with no planned replacement. According the Navy’s Official Fact File, OHP ships fulfill the ASW mission protecting expeditionary forces, underway replenishment groups, and merchant convoys.⁹⁵ After their MK-13 missile launchers were removed from all OHP’s due to cost and maintenance issues they lost any anti-air warfare capability. Missions that OHP Frigates currently conduct include: deploying

independently in low threat environments in support of counter-drug operations, MIO, and the Seventh Fleet Cooperation Afloat, and Readiness and Training (CARAT) missions.⁹⁶ Those missions could be supportable by LCS. Another benefit to these missions are frequent port calls offering time for crew swaps, refueling, maintenance actions, improving crew morale, and allowing for mission module changes (if needed).

LCS should be stationed forward around the world. The recent announcement to station four LCS ships in Singapore is a great plan. Having LCS operate from forward bases would negate many issues with the class. Operating close to their home base would facilitate crew rotations, mission module changes, and allow for the periodic maintenance LCS requires. With the Obama administration talking with the Philippines about expanding the U.S. military presence there, Subic Bay naval base could be another place to station LCS.⁹⁷ Secretary of the Navy Ray Mabus announced that the Navy is going to move four *Arleigh Burke*-class DDG destroyers to Rota, Spain.⁹⁸ LCS ships could also be home-ported in Rota and Bahrain to cover the Mediterranean Ocean and Arabic Sea.

Medium to high threat missions including deploying with aircraft carrier battle groups and/or Expeditionary Strike Groups (ESG), which are amphibious ships combined with surface combatants, will require another tactic and concept. A solution would be to marry an LCS to a surface combatant such as a destroyer or cruiser. Networked together, both ships' sensors would extend the area and scope of the Recognized Maritime Picture (RMP). RMP is a plot of contacts and any information known about them, in which gives the ship situational awareness. By balancing each ship's strengths and weaknesses, an LCS/DDG or LCS/CG team would greatly increase the combat power over fighting alone. This tactic will be looked at in relation to Aviation, ASW and SUW:

Aviation: Two air capable ships greatly increase the effectiveness of aircraft. With one ship's helicopter airborne, the second ship can act as a "lily pad" which can double the range the helicopter can operate from its parent ship. The "lily pad" ship extends radio and navigation communications to the helicopter so it range farther than operating with just one ship. The "lily pad" also offers an additional flight deck in the event of an emergency, a refueling platform, and can even take control of MH-60R LAMPS helicopter with its ASW/SUW Tactical Air Controller (ASTAC). With both ships and helicopter in data link with each other, anything one sees is shared real-time with others, thus greatly increasing situational awareness in building RMP. Even an older, "Flight I" DDG with no hangar or organic helicopter could expand the range of the LCS's helicopter because it still has a flight deck with refueling capability, datalink, and ASTACs.

ASW: The LCS is inherently weak in defensive ASW as it has no hull mounted sonar, no torpedo launchers, and has to be configured with an ASW module and have its sonar tail streamed and/or its remote vehicle in the water. A DDG or CG (CRUDES) ship has a full ASW suite that can augment an LCS with its ASW package, or help protect an SUW configured LCS. A CRUDES ship using its AN/SQQ-89 system (comprised of its hull mounted sonar and AN/SQR-19 towed array sonar) can listen for submarines. CRUDES ships also carry the MK-32 torpedo launcher, which can remotely launch torpedoes for an urgent attack.

SUW: In the SUW role, the LCS can dominate a local gunfight with its cannons and machine guns, but is limited in range with the planned Griffin missile system. Having a CRUDES ship in datalink, they could share and fire off tracks in the link by using the CRUDES's Standard Missiles from its Vertical Launch System (VLS) or Harpoon missiles. This increases the range for surface attacks. The LCS's other major strength is its high speed and

shallow draft, which makes it a game changer in the MIO or counter-drug environment.

CONCLUSION

LCS represents the new direction the Navy is taking with its surface forces. The so called “lego ship” that can be quickly configured for the mission, this class will be doing much of the Navy’s work in the future. With 55 LCS ships planned out of the 285-ship Navy of the future, LCS will be a major player. Those 55 ships will take part of replacing the future loss of 30 FFG-7 *Oliver Hazard Perry* class frigates, 14 MCM *Avenger* class mine countermeasures vessels, 12 MHC-51 *Osprey* Class coastal mine hunters, and seven *Ticonderoga* class Cruisers that will be decommissioned. That is 55 LCS ships replacing 63 ships, of which the seven cruisers are the most capable surface combatants the Navy has ever put to sea.

LCS missions include ASW, SUW and MIW. Currently, in 2012, ASW can only be conducted by the MH-60R helicopter. None of the ship’s organic equipment, such as the remote unmanned vehicle to operate sonar, is operational. LCS cannot currently conduct any MIW as the RMMV remote vehicle is still in testing. SUW can be conducted to a limited degree, but the Griffin missile system is not yet fielded. However, over time, these problems and challenges will be resolved.

Survivability issues, while getting attention from Congress, are not seen as a problem for the Navy. LCS will continue with its current Level I+ protection. While the LCS is built to be an affordable and minimally protected ship, if one were to be sunk the political cost of losing a U.S. Navy warship would be costly. The last U.S. Navy ship to be sunk was the USS *Sarsi* (ATF-111) after striking a mine at Hungnam, North Korea, killing two, on August 27, 1952.⁹⁹

Budget issues appear to be of minimal long-range impact. There will be a slow down of

building but no change in the final number of 55 LCS ships. Crew manning is still in the experimental phase, with ships trying different types of crew rotations to reduce workload and fatigue. With only one counter-drug deployment completed to date, that has yet to be determined. It remains to be seen how the Navy will employ LCS in the future. With the current plan locate four LCS in Singapore, the future points to overseas basing.

APPENDIX A – Acronyms

ADS – Advanced Deployable System

ALMDS - Airborne Laser Mine Detection System

ASTAC - ASW/SUW Tactical Air Controller

ASW – Anti-Submarine Warfare

CBR - Chemical, Biological, Radiological

CIC – Combat Information Center

CVN – Nuclear Aircraft Carrier

CG – Aegis Guided Missile Cruiser

CNO – Chief of Naval Operations

CRUDES – Cruiser/Destroyer

DD - Destroyer

DDG – Guided Missile Destroyer

DoD – Department of Defense

EO – Electro-Optical

EMP – Electro-magnetic Pulse

FAC/FIAC -- Fast Attack Craft/Fast Inshore Attack Craft

FLIR – Forward Looking Infrared

FPI – Fixed Price Incentive

FYDP- Five Year Defense Plan

HSL – Helicopter Anti-Submarine Light

ICCP - Impressed Current Cathodic Protection System

ISAR – Inverse Synthetic Aperture Radar

JHSV – Joint High Speed Vessel

LAMPS – Light Airborne Multi-Purpose System

LWT – Light Weight Tow

MCM – Mine Counter Measures

MFTA -- Multi-function Towed Array

MIO – Maritime Interdiction Operations

MIW – Mine Warfare

MP – Mission Package

MPSF -- Mission Package Support Facility

NAVSEA -- Naval Sea Systems Command

NGFS – Naval Gunfire Support

NLOS-LS -- Non-Line of Sight Launch System Mission Module

OSD -- Office of State Department

PA&E -- Program Analysis and Evaluation

RAM – Rolling Airframe Missiles

RAMCS - Rapid Airborne Mine Clearance System

RHIB – Rigid Hull Inflatable Boat

RMMV -- Remote Multi-Mission Vehicle

RMP – Recognized Maritime Picture

SAR – Search and Rescue

SRBOC -- Super Rapid-Bloom Off-Shore Countermeasures

SUW – Anti-Surface Warfare

SWATH - Small Water-Plane Area Twin Hull

TCOL -- Tactical Common Data Link

TDM – Torpedo Defense Module

QDR -- Quadrennial Defense Review

UAV – Unmanned Aerial Vehicle

VDS – Variable Depth Sonar

VBSS – Visit, Board, Search and Seizure

VERTREP – Vertical Replenishment

APPENDIX B – LCS General Characteristics

General Characteristics, *Freedom* variant

Builder: Lockheed Martin

Length: 378 ft. (115.3 meters)

Beam: 57.4 ft. (17.5 meters)

Displacement: approximately 3,000 MT full load

Draft: 12.8 ft. (3.9 meters)

Speed: 40+ knots

Ships:

USS Freedom (LCS 1), San Diego, CA.

PCU (Pre-Commissioned Unit) Fort Worth (LCS 3), (future) San Diego, CA. - under construction

PCU Milwaukee (LCS 5) - under construction

PCU Detroit (LCS 7) - under construction

General Characteristics, *Independence* variant

Builder: General Dynamics

Length: 419 ft. (127.6 meters)

Beam: 103.7 ft. (31.6 meters)

Displacement: approximately 3,000 MT full load

Draft: 14.1 ft (4.3 meters)

Ships:

USS Independence (LCS 2), San Diego, CA.

USS Coronado (LCS 4), (future) San Diego, CA.

PCU Jackson (LCS 6), (future) San Diego, CA. - under construction

PCU Montgomery (LCS 8) - under construction

Source: The US Navy – Fact File: LITTORAL COMBAT SHIP CLASS - LCS, December 15, 2011, accessed 08 January, 2012,

http://www.navy.mil/navydata/fact_display.asp?cid=4200&tid=1650&ct=4

APPENDIX C – Illustrations *USS FREEDOM* (LCS-1)



USS FREEDOM (LCS-1) with MH-60R on final approach



USS FREEDOM (LCS-1) with MH-60R

Source: U.S. Navy official website: www.navy.mil/search/photolist.asp, accessed 8 January 2012.

APPENDIX D – Illustrations USS *INDEPENDENCE* (LCS-2)



Source: U.S. Navy official website: www.navy.mil/search/photolist.asp, accessed 8 January 2012.

APPENDIX E – Illustrations LCS-3 and LCS-4



FORT WORTH (LCS-3) Launched December 4, 2010



CORONADO (LCS-4) Christened January 14, 2012

Source: U.S. Navy official website: www.navy.mil/search/photolist.asp, accessed 8 January 2012.

APPENDIX F – Illustration and Specifications MH-60S Seahawk



MH-60S from HSC-22 takes off from USS *Freedom* (LCS-1)

Mission:

The MH-60S Seahawk missions are Anti-Surface Warfare, Combat Support, Humanitarian Disaster Relief, Combat Search and Rescue, Medical Evacuation, SPECWAR and Airborne Mine Countermeasures.

Specifications:

Primary Function: Anti-Surface Warfare, Combat Support, Humanitarian

Date Deployed: 2002

Propulsion: 2-GE T700-GE-401 (C)

Length: 64 feet, 10 inches

Height: 17 feet

Weight: 14,430 lbs (empty), 23,500 lbs (max gross)

Airspeed: 180 knots (max)

Ceiling: 13,000 feet

Range: 245 Nautical Miles

Crew: Four

Source:

<http://www.navair.navy.mil/index.cfm?fuseaction=home.displayPlatform&key=A1C74EA2-3917-416B-81C6-9CEB537C0594>, accessed 17 January, 2012.

APPENDIX G – Illustration and Specifications MH-60R Seahawk



Mission:

The MH-60R Seahawk missions are Anti-Submarine Warfare, Anti-Surface Warfare, Surveillance, Communications Relay, Combat Search and Rescue, Naval Gunfire Support and Logistics Support.

Specifications:

Primary Function: Anti-Submarine Warfare, Surface Warfare Helicopter

Date Deployed: 2006

Propulsion: 2-GE T700-GE-401 (C)

Length: 64 feet, 10 inches

Height: 17 feet

Weight: 14,430 lbs (empty), 23,500 lbs (max gross)

Airspeed: 180 knots (max)

Ceiling: 13,000 feet

Range: 245 Nautical Miles

Crew: Three

Source:

<http://www.navair.navy.mil/index.cfm?fuseaction=home.displayPlatform&key=230E736F-D36A-4FB8-BDD3-372CD723D22C>. Accessed January 17, 2012.

APPENDIX H – Illustration and Specifications MQ-8B Fire Scout



Specifications:

Fuselage Length (with Dual Payload Nose): 23.95 ft (7.3 m)
Fuselage Width: 6.20 ft (1.9 m)
Length (with Blades Folded Forward): 30.03 ft (9.2 m)
Rotor Diameter: 27.50 ft (8.4 m)
Height (Top of Tail Antenna): 9.71ft (2.9 m)
Gross Weight: 3,150 lbs (1428.8 kg)
Engine: Rolls Royce 250-C20W Turboshaft Engine
Speed: 115+ Knots
Ceiling: 20,000 ft (6.1 km)

Endurance:

Total Flight Time with Baseline Payload: 8+ Hours
Total Flight Time with EO/IR + Radar: 7+ Hours
Total Flight Time with Maximum Payload: 5+ Hours

Payloads:

EO/IR/LRF/Mine Detector/Comm Relay/Maritime Radar

Source: Northrop Grumman website:

http://www.as.northropgrumman.com/products/mq8bfirescout_navy/assets/fsn_ds.pdf, accessed January 13, 2012.

APPENDIX I – Illustration and Specifications *Arleigh Burke* class Destroyer (DDG)



USS *Spruance* (DDG-111) Conducting Sea Trials

Features:

Guided missile destroyers are multi-mission [Anti-Air Warfare (AAW), Anti-Submarine Warfare (ASW), and Anti-Surface Warfare (ASUW)] surface combatants. The destroyer's armament has greatly expanded the role of the ship in strike warfare utilizing the MK-41 Vertical Launch System (VLS).

General Characteristics, *Arleigh Burke* class

Builder: Bath Iron Works, Huntington Ingalls Industries

SPY-1 Radar and Combat System Integrator: Lockheed-Martin

Date Deployed: July 4, 1991 (USS *Arleigh Burke*)

Propulsion: Four General Electric LM 2500-30 gas turbines; two shafts, 100,000 total shaft horsepower.

Length: Flights I and II (DDG 51-78): 505 feet (153.92 meters)

Flight IIA (DDG 79 AF): 509½ feet (155.29 meters).

Beam: 59 feet (18 meters).

Displacement: DDG 51 through 71: 8,230 L tons (8,362.06 metric tons) full load DDG 72 through 78: 8,637 L tons (8,775.6 metric tons) full load DDG 79 and Follow: 9,496 L tons (9,648.40 metric tons) full load.

Speed: In excess of 30 knots.

Crew: 276

Armament: Standard Missile (SM-2MR); Vertical Launch ASROC (VLA) missiles; Tomahawk®; six MK-46 torpedoes (from two triple tube mounts); Close In Weapon System (CIWS), 5" MK 45 Gun, Evolved Sea Sparrow Missile (ESSM) (DDG 79 AF)

Source: Navy fact file website:

http://www.navy.mil/navydata/fact_display.asp?cid=4200&tid=900&ct=4, accessed January 17, 2012.

APPENDIX J – Illustration and Specifications *Ticonderoga* class Cruiser (CG)



Features

Modern U.S. Navy guided missile cruisers perform primarily in a Battle Force role. These ships are multi-mission [Air Warfare (AW), Undersea Warfare (USW), Naval Surface Fire Support (NSFS) and Surface Warfare (SUW)] surface combatants capable of supporting carrier battle groups, amphibious forces, or of operating independently and as flagships of surface action groups. Cruisers are equipped with *Tomahawk* cruise missiles giving them additional long range Strike Warfare (STRW) capability. Some Aegis Cruisers have been outfitted with a Ballistic Missile Defense (BMD) capability.

General Characteristics, *Ticonderoga* Class

Builder: Ingalls Shipbuilding: CG 47-50, CG 52-57, 59, 62, 65-66, 68-69, 71-73

Bath Iron Works: CG 51, 58, 60-61, 63-64, 67, 70.

Date Deployed: 22 January 1983 (*USS Ticonderoga*)

Unit Cost: About \$1 billion each.

Propulsion: 4 General Electric LM 2500 gas turbine engines; 2 shafts, 80,000 shaft horsepower total.

Length: 567 feet.

Beam: 55 feet.

Displacement: 9,600 tons (9,754.06 metric tons) full load.

Speed: 30 plus knots.

Crew: 24 Officers, 340 Enlisted.

Armament: MK41 vertical launching system Standard Missile (MR); Vertical Launch ASROC (VLA) Missile; Tomahawk Cruise Missile; Six MK-46 torpedoes (from two triple mounts); Two MK 45 5-inch/54 caliber lightweight guns; Two Phalanx close-in-weapons systems.

USS Mobile Bay (CG-53) Underway

Source: Navy fact file website:

http://www.navy.mil/navydata/fact_display.asp?cid=4200&tid=800&ct=4, accessed January 17, 2012.

APPENDIX K – Illustration and Specifications 11-Meter RHIB



Features

The 11-meter-long Naval Special Warfare Rigid Hull Inflatable Boats (RHIB) are constructed of composites with an inflatable tube gunwale made of reinforced fabric. They can operate in heavy seas and winds of 45 knots, but for other than heavy-weather training, the Navy limits its use to somewhat milder sea conditions (wind speed is less than 34 knots). The RHIB carries a crew of three and a SEAL element.

General Characteristics, 11 meter Naval Special Warfare RHIB

Propulsion: Dual Caterpillar 3126 DITA, 6 in-line cylinder diesel, turbocharged, aftercooled.

Length: 35 feet 11 inches (11 meters) (Overall, inflated tube).

Beam: 10 feet 7 inches (3.2 meters) (sponson inflated); 8 feet 9 inches (2.6 meters) (deflated).

Displacement: 17,400 lbs, (7,892 kilograms).

Draft: 2 feet 11 inches (0.9 meters).

Speed: 40+ knots (nautical miles per hour) (64 kilometers/hour).

Range: 200 nautical miles (370 kilometers).

Crew: 3 and a SEAL squad.

Armament: M60 7.62mm machine gun, MK19 40mm, M2 .50 cal. machine gun.

Source: Navy fact file website:

http://www.navy.mil/navydata/fact_display.asp?cid=4200&tid=2200&ct=4, accessed January 13, 2012.

APPENDIX L – Illustration and Specifications Joint High Speed Vessel (JHSV)



Features

JHSV will be capable of transporting 600 short tons 1,200 nautical miles at an average speed of 35 knots. The ships will be capable of operating in shallow-draft ports and waterways, interfacing with roll-on/roll-off discharge facilities, and on/off-loading a combat-loaded Abrams Main Battle Tank (M1A2). The JHSV will include a flight deck for helicopter operations and an off-load ramp that will allow vehicles to quickly drive off the ship. The ramp will be suitable for the types of austere piers and quay walls common in developing countries. JHSV's shallow draft (under 15 feet) will further enhance littoral operations and port access.

JHSV is a commercial-design, non-combatant transport vessel. It does not require the survivability and ability to sustain damage like the LCS. It has no combat system capability and no ability to support or use LCS mission modules. Select military features include Aviation; Command, Control, Communications, Computers, and (Military) Intelligence; Firefighting for the Mission Bay; and four (4) .50 Caliber Machine Guns.

JHSVs will have a crew of 21 people, but will have airline style seating for more than 312 embarked forces and fixed berthing for 146. Military Sealift Command (MSC) will operate and sustain the JHSVs. JHSV will be allocated via Global Force Management (GFM) for Theater Security Cooperation (TSC), service unique missions, intra-theater sealift, and special missions.

General Characteristics

Builder: Austal USA

Propulsion: Water Jet

Length: 103 Meters (338 feet)

Beam: 28.5 meters (93.5 feet)

Displacement: 2362 long tons

Draft: 13 feet (3.97 meters)

Speed: 35-40 knots

Range: 1,200 nautical miles

Source: Navy fact file website:

http://www.navy.mil/navydata/fact_display.asp?cid=4200&tid=1400&ct=4, accessed February 10, 2012.

APPENDIX M – TIMELINE

- **1999**, Streetfighter concept introduced.
- **2001**, 2001 QDR announces the LCS
- **February 2002**, LCS Program Office established
- **27 May 2004**, the Navy awarded contracts to two industry teams Lockheed Martin (LM) and General Dynamics (GD)
- **23 September 2006**, *Freedom* (LCS-1) launched at the Marinette marine shipyard
- **30 April 2008**, *Independence* (LCS-2) is launched at the Austal USA shipyard
- **08 November 2008**, USS *Freedom* commissioned
- **22 January 2010**, USS *Freedom* Deploys for Counter-drug Operations off Central and South America and the Caribbean (4th Fleet)
- **16 January 2010**, USS *Independence* commissioned
- **23 April 2010**, USS *Freedom* returns from her maiden deployment
- **04 December 2010**, *Fort Worth* (LCS-3) is launched
- **16 June 2011**, First successful launch and recovery of the Remote Multi-Mission Vehicle from an LCS.
- **15 July 2011**, Secretary of the Navy Ray Mabus announces that a future *Freedom* class ship will be named *Little Rock* (LCS-9).
- **27 October 2011**, Keel laying ceremony for *Milwaukee* (LCS-5) in Marinette shipyard.
- **14 January 2012**, *Coronado* (LCS-4) Christened at Austal USA Shipyard in Mobile, AL
- **10 February 2012**, Secretary of the Navy Ray Mabus announces that the future *Independence* class ship will be named *Gabrielle Giffords* (LCS-10).
- **15 February 2012**, Secretary of the Navy Ray Mabus announces that the future LCS-10 will be the *Sioux City* and LCS-11 will be the *Omaha*.

ENDNOTES

¹ Vice Admiral A. K. Cebrowski, USN and Captain Wayne P. Hughes, Jr., USN (Ret.), “Rebalancing the Fleet,” *Proceedings*, (November 1999): 4. <http://www.usni.org/magazines/proceedings/1999-11/rebalancing-fleet>. (accessed December 31, 2011).

² Cebrowski, 4.

³ Admiral Jay L. Johnson, USN, “Numbers do Matter,” *Proceedings*, (November 1999): 4. <http://www.usni.org/magazines/proceedings/1999-11/rebalancing-fleet>. (accessed December 31, 2011).

⁴ Johnson, “Numbers do Matter,” 3.

⁵ Duncan Long and Stuart Johnson, “The Littoral Combat Ship: From Concept to Program,” *Case Studies in National Security Transformation No. 7*, March 2007, 8, <http://www.ndu.edu/CTNSP/docUploaded/case%207%20LCS.pdf>. (accessed December 31, 2011).

⁶ Long and Johnson, “The Littoral Combat Ship: From Concept to Program,” 8.

⁷ Defense Industry Daily, “The USA’s DDG-1000 Zumwalt Class Program: Dead Aim, or Dead End?” January 3, 2012. <http://www.defenseindustrydaily.com/dead-aim-or-dead-end-the-usa-ddg1000-zumwalt-class-program-02574>, (accessed February 15, 2012).

⁸ U.S. Department of the Navy, “Sea Power 21,” (Washington, DC: US Department of the Navy, October 2002). 1, <http://www.navy.mil/navydata/cno/proceedings.html>. (accessed December 23, 2011).

⁹ Long and Johnson, “The Littoral Combat Ship: From Concept to Program,” 10.

¹⁰ Ronald O’Rourke, “Navy Littoral Combat Ship (LCS) Program: Background, Issues, and Options for Congress,” CRS Report RL33741, (Congressional Research Service (CRS), Washington DC, April 29, 2011), 2, <http://www.fas.org/sgp/crs/weapons/RL33741.pdf>. (accessed January 8, 2011)

¹¹ LCDR Edmund J. Handley, USN, “US Navy Littoral Combat Ship (LCS) Capabilities, Risks, Possible Missions, and Modules to Support Future USMC Operating Concepts.” Masters of Military Studies Paper, Marine Corps Command and Staff College, 2010, 9. <http://65.114.145.226/isysquery/9b9d8ab8-1e7e-4755-a118-febd00a30f77/3/doc/>. (accessed November 20, 2011).

¹² Handley, “US Navy Littoral Combat Ship (LCS) Capabilities, Risks, Possible Missions, and Modules to Support Future USMC Operating Concepts,” 9.

¹³ “Littoral Combat Ship (LCS), United States of America.” Accessed January 12, 2012, <http://www.naval-technology.com/projects/littoral>.

¹⁴ U.S. Department of the Navy, “United States Navy Fact File: Littoral Combat Ship Class – LCS,” December 15, 2011. http://www.navy.mil/navydata/fact_display.asp?cid=4200&tid=1650&ct=4. (accessed January 9, 2012). Sea State 5 on the Beaufort Scale is 6-9 foot seas and “Moderate waves of some length. Many whitecaps. Small amounts of spray.”

¹⁵ Christopher Cavas, “LCS 1 Vs. 2: Both Meet the Requirements, But Similarities End There,” *Defense News*, May 3, 2010, <http://www.defensenews.com/article/20100503/DEFSECT03/5030307/LCS-1-Vs-2-Both-Meet-Requirements-Similarities-End-There>. (accessed February 10, 2012).

-
- ¹⁶ General Dynamics, *Maximum Combat Power and Agility for the 21st Century*, January 4, 2007, <http://www.gdlcs.com/sites/default/files/MMC-Brochure.pdf>. (accessed January 13, 2012).
- ¹⁷ General Dynamics, 3.
- ¹⁸ Christopher Cavas, "LCS 1 Vs. 2: Both Meet the Requirements, But Similarities End There,".
- ¹⁹ BAE Systems, *BOFORS 57MM MK3 Naval Gun System*, http://www.baesystems.com/ProductsServices/bae_prod_bofors_mm_mk_three.html. (accessed January 13, 2012).
- ²⁰ "Littoral Combat Ship (LCS), United States of America," <http://www.naval-technology.com/projects/littoral>. (accessed January 12, 2012).
- ²¹ <http://www.naval-technology.com/projects/littoral>
- ²² <http://www.naval-technology.com/projects/littoral>
- ²³ U.S. Department of the Navy, "United States Navy Fact File: Littoral Combat Ships- Anti-Submarine Warfare (ASW) Mission Package," November 23, 2011. http://www.navy.mil/navydata/fact_display.asp?cid=2100&tid=412&ct=2. (accessed January 16, 2012).
- ²⁴ U.S. Department of the Navy, "United States Navy Fact File: Littoral Combat Ships- Mission Modules," November 23, 2012. http://www.navy.mil/navydata/fact_display.asp?cid=2100&tid=406&ct=2. (accessed January 16, 2012).
- ²⁵ "United States navy Fact File: Littoral Combat Ships - Mission Modules,"
- ²⁶ "Littoral Combat Ship: Surface Warfare Mission Package," Naval Sea Systems Command, <http://www.navsea.navy.mil/nswc/dahlgren/ET/LCS/LCS.pdf>. (accessed January 13, 2012).
- ²⁷ "Littoral Combat Ship: Surface Warfare Mission Package," Naval Sea Systems Command.
- ²⁸ U.S. Department of the Navy, "United States Navy Fact File: MK 46 – 30mm Gun Weapon System," November 2, 2011. http://www.navy.mil/navydata/fact_display.asp?cid=2100&tid=525&ct=2, (accessed February 10, 2012).
- ²⁹ O'Rourke, "Navy Littoral Combat Ship (LCS) Program: Background, Issues, and Options for Congress," 10.
- ³⁰ "Littoral Combat Ship: Surface Warfare Mission Package," Naval Sea Systems Command.
- ³¹ "United States Navy Fact File: Littoral Combat Ships- Anti-Submarine Warfare (ASW) Mission Package".
- ³² Defense Industry Daily, "The USA's New Littoral Combat Ships (LCS)," December 19, 2011, <http://www.defenseindustrydaily.com/the-usas-new-littoral-combat-ships-updated-01343> (accessed January 15, 2012). It is unavailable in open source why the ADS program was cancelled in 2006.
- ³³ Defense Industry Daily, "The USA's New Littoral Combat Ships (LCS)."
- ³⁴ Defense Industry Daily, "Spartan USVs for Singapore's Navy," May 18, 2005, <http://www.defenseindustrydaily.com/spartan-usvs-for-singapores-navy-0540> (accessed March 4, 2012).
- ³⁵ O'Rourke, "Navy Littoral Combat Ship (LCS) Program: Background, Issues, and Options for Congress," 11.
- ³⁶ "United States Navy Fact File: Littoral Combat Ships- Anti-Submarine Warfare (ASW) Mission Package".

³⁷ LCDR Gregory Zimmerman, USN. The author has professional knowledge of alert status and launch times for helicopters. This information is also available in NAVAIR 00-80T-122 “NATOPS Helicopter Operating Procedures for Air Capable Ships”, which is not available to the public. Normal operations dictate “Alert 60” in which it takes an hour to launch a helicopter from the hangar. Additional time is needed to strike a torpedo from the ship’s magazine, load it on the helicopter, and load sonobuoys. If the helicopter is already spotted on deck and armed, launches can be made in 5, 15, or 30 minutes depending on the alert status set for the the crew and helicopter.

³⁸ Northrop Grumman, “Airborne Laser Mine Detection System (ALMDS),” <http://www.as.northropgrumman.com/products/almds/index.html> (accessed January 16, 2012).

³⁹ Government Accountability Office, *Defense Acquisitions: Navy’s Ability to Overcome Challenges Facing the Littoral Combat Ship Will Determine Eventual Capabilities* (Washington, DC: Government Accountability Office, August 2010, 18, <http://www.gao.gov/new.items/d10523.pdf> (accessed January 15, 2012).

⁴⁰ Northrop Grumman, “Rapid Airborne Mine Clearance System (RAMICS),” <http://www.as.northropgrumman.com/products/ramics/index.html> (accessed February 10, 2012).

⁴¹ Naval Mine Warfare, “US halts RAMICS,” May 31, 2011, <http://www.navalminewarfare.com/index.php/countries/43-united-states/109-us-halts-ramids>. (accessed February 10, 2012).

⁴² U.S. Department of the Navy, “United States Navy Fact File: Remote Multi-Mission Vehicle – (RMMV),” November 28, 2011. http://www.navy.mil/navydata/fact_display.asp?cid=2100&tid=453&ct=2. (accessed January 16, 2012).

⁴³ Lindsay Wilson, “Lockheed Martin Achieves Critical Reliability Testing Milestone on U.S. Navy Minehunting System,” *Lockheed Martin*, December 19, 2011, http://www.lockheedmartin.com/news/press_releases/2011/121911_LM_RMMV.html. (accessed January 16, 2012).

⁴⁴ “MH-60S Seahawk (Knighthawk), United States of America,” http://www.naval-technology.com/projects/mh_60s. (accessed January 18, 2012).

⁴⁵ “MH-60S Seahawk (Knighthawk), United States of America”

⁴⁶ NAVAIR, “H-60 Helicopters,” <http://www.navair.navy.mil/index.cfm?fuseaction=home.display&key=6E92F2F3-1104-42E4-86D0-BAF1B234AAAC>. (accessed February 10, 2012).

⁴⁷ Sikorsky, “MH-60R SEAHAWK Helicopter,” <http://www.sikorsky.com/StaticFiles/Sikorsky/Assets/Attachments/Mission%20Downloads/N-077%20August%202008.pdf>. (accessed February 10, 2012).

⁴⁸ Sikorsky, “MH-60R SEAHAWK Helicopter,”

⁴⁹ “MQ-8B,” Northrop Grumman, accessed January 14, 2012, http://www.as.northropgrumman.com/products/mq8bfireshout_navy/index.html.

⁵⁰ “MQ-8B,” Northrop Grumman.

⁵¹ “MQ-8B,” Northrop Grumman.

⁵² Gary Mortimer, “Northrop Grumman Fire Scout Completes Successful At-Sea Deployment,” *SUAS News*, August 17, 2011, <http://www.suasnews.com/2011/08/6552/northrop-grumman-fire-scout-completes-successful-at-sea-deployment> (accessed January 14, 2012).

⁵³ Mortimer. “Northrop Grumman Fire Scout Completes Successful At-Sea Deployment,”

-
- ⁵⁴ Gidget Fuentes, "New helo squadron will fly Fire Scouts, too," *Navy Times*, November 27, 2011, <http://www.navytimes.com/news/2011/11/navy-new-helicopter-squadron-will-fly-fire-scouts-112711w> (accessed January 14, 2012).
- ⁵⁵ Fuentes. "New helo squadron will fly Fire Scouts, too,"
- ⁵⁶ Fuentes. "New helo squadron will fly Fire Scouts, too,"
- ⁵⁷ Lt. Susan Henson, "LCS Crew to be Hybrid Sailors," *U.S. Navy.mil*, July 12, 2005, http://www.navy.mil/search/display.asp?story_id=19150. (accessed February 10, 2012).
- ⁵⁸ Claire Simms, "Hybrid Sailors Staff USS Independence," *First Coast News*, November 9 2011. <http://origin.firstcoastnews.com/news/military/article/225986/162/Hybrid-Sailors-Staff-USS-Independence>. (accessed February 10, 2012).
- ⁵⁹ Simms. "Hybrid Sailors Staff USS Independence."
- ⁶⁰ Grace V. Jean, "Duty aboard the Littoral Combat Ship: 'Grueling but Manageable'", September 2010, <http://www.nationaldefensemagazine.org/archive/2010/September/Pages/DutyAboardtheLittoralCombatShip%E2%80%98GruelingbutManageable%E2%80%99.aspx>. (accessed February 10, 2012).
- ⁶¹ John D. Gresham, "USS Freedom (LCS 1) Deploys," *Defense media network*, February 19, 2010. <http://www.defensemedianetwork.com/stories/uss-freedom-lcs-1-deploys>, (accessed January 18, 2012).
- ⁶² Gresham. "USS Freedom (LCS 1) Deploys,"
- ⁶³ Chad Witlock, "Obama's Asia strategy gives Navy key role, fewer ships," *The Washington Post*, February 15, 2012. http://www.washingtonpost.com/world/national-security/obamas-asia-strategy-gives-navy-key-role-fewer-ships/2012/02/15/gIAhnNgGR_story.html (accessed March 4, 2012).
- ⁶⁴ LCDR Roy Zaletski, USN, OIC, HSC-22 Detachment TWO to Commanding Officer, H-60R/S Fleet Introduction Team, April 23, 2010. HSC-22 Det TWO/FREEDOM (GOLD) Early Deployment Lessons Learned, 9.
- ⁶⁵ LCDR Jeff Sowers, USN, OIC, HSC-22 Detachment TWO to Commanding Officer, HELSEACOMBATRON TWO TWO, October 12, 2010, HSC-22 Det TWO/FREEDOM (BLUE) Deployment Lessons Learned, 12.
- ⁶⁶ LCDR Jeff Sowers, 3.
- ⁶⁷ LCDR Jeff Sowers, 3.
- ⁶⁸ Jean, "Duty aboard the Littoral Combat Ship: 'Grueling but Manageable'."
- ⁶⁹ O'Rourke, "Navy Littoral Combat Ship (LCS) Program: Background, Issues, and Options for Congress," 2.
- ⁷⁰ O'Rourke, "Navy Littoral Combat Ship (LCS) Program: Background, Issues, and Options for Congress," 9.
- ⁷¹ O'Rourke, "Navy Littoral Combat Ship (LCS) Program: Background, Issues, and Options for Congress," 9.
- ⁷² Christopher P. Cavas, "Despite Cuts, Navy shipbuilding gets priority," *Navy Times*, January 16, 2012, <http://www.navytimes.com/news/2012/01/navy-fleet-sean-stackley-shipbuilding-remains-priority-011612w> (accessed January 18, 2012).
- ⁷³ O'Rourke, "Navy Littoral Combat Ship (LCS) Program: Background, Issues, and Options for Congress," 2.

-
- ⁷⁴ U.S. Department of the Navy, "Summary of the DoD Fiscal 2013 Budget Proposal," *Navy News Service*. <http://www.defense.gov/news/2013budget.pdf>. (accessed February 14, 2012).
- ⁷⁵ O'Rourke, "Navy Littoral Combat Ship (LCS) Program: Background, Issues, and Options for Congress," 24.
- ⁷⁶ O'Rourke, "Navy Littoral Combat Ship (LCS) Program: Background, Issues, and Options for Congress," 24.
- ⁷⁷ O'Rourke, "Navy Littoral Combat Ship (LCS) Program: Background, Issues, and Options for Congress," 24.
- ⁷⁸ David Lerman and Tony Capaccio, "Navy Finds 'Aggressive' Corrosion on New Ship," *Bloomberg*, June 17, 2011. <http://www.bloomberg.com/news/2011-06-17/navy-finds-aggressive-corrosion-on-austal-s-combat-ship-1-.html>. (accessed January 19, 2012).
- ⁷⁹ Edward Lundquist, "Lessons Learned Lead to Improvements in Follow-on LCS Ships," *MarinLink.com*, December 5, 2011. <http://www.marinelink.com/news/improvements-littoral341595.aspx>. (accessed January 19, 2012).
- ⁸⁰ Gresham, "USS Freedom (LCS 1) Deploys."
- ⁸¹ Government Accountability Office, *Defense Acquisitions*, 37.
- ⁸² Government Accountability Office, *Defense Acquisitions*, 37.
- ⁸³ O'Rourke, "Navy Littoral Combat Ship (LCS) Program: Background, Issues, and Options for Congress," 18.
- ⁸³ U.S. Department of the Navy, "United States Navy Fact File: Joint High Speed Vessel – JHSV," November 10, 2011. http://www.navy.mil/navydata/fact_display.asp?cid=4200&tid=1400&ct=4. (accessed January 17, 2012).
- ⁸⁴ U.S. Department of the Navy, "United States Navy Fact File: Joint High Speed Vessel – JHSV."
- ⁸⁵ Dan Murtaugh, "Austal gets \$322M for the next two JHSVs," *al.com*, February 24, 2012. http://blog.al.com/live/2012/02/austal_gets_322m_for_next_two.html (accessed March 4, 2012).
- ⁸⁶ "United States Navy Fact File: Joint High Speed Vessel – JHSV"
- ⁸⁷ "United States Navy Fact File: Joint High Speed Vessel – JHSV"
- ⁸⁸ "United States Navy Fact File: Joint High Speed Vessel – JHSV"
- ⁸⁹ Government Accountability Office, *Defense Acquisitions*, 4.
- ⁹⁰ O'Rourke, "Navy Littoral Combat Ship (LCS) Program: Background, Issues, and Options for Congress," 16. On the Beaufort scale, Sea State 8 is 18-25 foot seas and "Moderately high waves with breaking crests forming spindrift. Well-marked streaks of foam are blown along wind direction. Considerable airborne spray."
- ⁹¹ O'Rourke, "Navy Littoral Combat Ship (LCS) Program: Background, Issues, and Options for Congress," 15.
- ⁹² O'Rourke, "Navy Littoral Combat Ship (LCS) Program: Background, Issues, and Options for Congress," 17.
- ⁹³ U.S. Department of the Navy, "USS Mesa Verde Completes Shock Trials," September 18, 2008, http://www.navy.mil/search/display.asp?story_id=39846. (accessed January 19, 2012).
- ⁹⁴ O'Rourke, "Navy Littoral Combat Ship (LCS) Program: Background, Issues, and Options for Congress," 23.

⁹⁵ U.S. Department of the Navy, “United States Navy Fact File: Frigates – FFG,” November 2, 2011. http://www.navy.mil/navydata/fact_display.asp?cid=4200&ct=4&tid=1300Nov. (accessed February 14, 2012).

⁹⁶ LCDR Gregory Zimmerman, USN. Author has personal experience with these facts as he deployed twice on OHP class Frigates. Information unavailable in open source.

⁹⁶ U.S. Naval History & Heritage Command, “U.S. Navy Ships: Sunk & Damaged in Action during the Korean Conflict,” <http://www.history.navy.mil/faqs/faq82-4.htm> (accessed February 15, 2012).

⁹⁷ Witlock Chad. “Obama’s Asia strategy gives Navy key role, fewer ships.”

⁹⁸ U.S. Department of the Navy, “Navy Names Forward Deployed Ships to Rota, Spain,” February 16, 2012. http://www.navy.mil/search/display.asp?story_id=65393 (accessed March 4, 2012).

Bibliography- Primary Sources

BAE Systems. "BOFORS 57MM MK3 Naval Gun System."
http://www.baesystems.com/ProductsServices/bae_prod_bofors_mm_mk_three.html. (accessed January 13, 2012).

Builder's information on the LCS main gun.

General Dynamics, *Maximum Combat Power and Agility for the 21st Century*. January 4, 2007.
<http://www.gdlcs.com/sites/default/files/MMC-Brochure.pdf>. (accessed January 13, 2012).

Builder's information on the *Independence* Class LCS.

Clark, Vern, ADM, USN. "Sea Power 21." Washington, DC: US Department of the Navy, October 2002. <http://www.navy.mil/navydata/cno/proceedings.html>. (accessed December 23, 2011).

Strategy paper written in 2002 describing how the Navy will posture for the 21st century.

Henson, Susan, LT USN. "LCS Crew to be Hybrid Sailors," *U.S. Navy.mil*. July 12, 2005.
http://www.navy.mil/search/display.asp?story_id=19150. (accessed February 10, 2012).

Navy.mil news release on LCS and workforce/crew manning.

NAVAIR, "H-60 Helicopters."
<http://www.navair.navy.mil/index.cfm?fuseaction=home.display&key=6E92F2F3-1104-42E4-86D0-BAF1B234AAAC>. (accessed February 10, 2012).

Information and technical details of the MH-60S and MH-60R helicopters.

Naval Sea Systems Command. "Littoral Combat Ship: Surface Warfare Mission Package."
<http://www.navsea.navy.mil/nswc/dahlgren/ET/LCS/LCS.pdf>. (accessed January 13, 2012).

NAVSEA information on the LCS Surface Warfare Mission Package.

Navy Technology.com. "US Navy Discovers Corrosion on New Austal LCS." <http://naval-technology.com/news/news122188.html>. (accessed December 8, 2011).

Short news clip about hull cracking in LCS 1.

Northrop Grumman. "Airborne Laser Mine Detection System (ALMDS)."
<http://www.as.northropgrumman.com/products/almds/index.html>. (accessed January 16, 2012).

Builder's information on the ALMDS system.

Northrop Grumman. "MQ-8B Fire Scout."

http://www.as.northropgrumman.com/products/mq8bfireshout_navy/index.html. (accessed January 14, 2012).

Information on the MQ-8B Fire Scout with specifications and details.

Northrop Grumman. "Rapid Airborne Mine Clearance System (RAMICS)."

<http://www.as.northropgrumman.com/products/ramics/index.html>. (accessed February 10, 2012).

Information on the RAMICS system

O'Rourke, Ronald. "Navy Littoral Combat Ship (LCS) Program: Background, Issues, and Options for Congress." CRS Report RL33741. Washington DC, Congressional Research Service (CRS), April 29, 2011. <http://www.fas.org/sgp/crs/weapons/RL33741.pdf>. (accessed December 8, 2011).

78 page report for Congress on the LCS program, funding, issues for Congress in relation to growth in procurement costs, changes in mission modules, issues with combat survivability, hull cracks on LCS 1. This was a great source of information for this MMS.

Sikorsky, "MH-60R SEAHAWK

Helicopter<http://www.sikorsky.com/StaticFiles/Sikorsky/Assets/Attachments/Mission%20Downloads/N-077%20August%202008.pdf>." (accessed February 10, 2012).

Detailed .pdf brochure will all specs and stats for the MH-60R helicopter

Sowers, Jeff, LCDR, OIC, HSC-22 Detachment TWO to Commanding Officer, HELSEACOMBATRON TWO TWO, October 12, 2012, HSC-22 Det TWO/FREEDOM (BLUE) Deployment Lessons Learned.

Valuable information from the Officer in Charge of the aviation department that was on USS *Freedom's* Maiden deployment, BLUE crew. Lesson's Learned documents describe issues, problems, and possible solutions to them.

U.S. Department of the Navy. *United States Navy Fact File: Frigates – FFG*. November 2, 2011http://www.navy.mil/navydata/fact_display.asp?cid=4200&ct=4&tid=1300Nov. (accessed February 14, 2012).

U.S. Department of the Navy. *United States Navy Fact File: MK 46 – 30mm Gun Weapon System*. November 2, 2011.

http://www.navy.mil/navydata/fact_display.asp?cid=2100&tid=525&ct=2. (accessed February 10, 2012).

U.S. Department of the Navy. "Naval Operations concept 2010 (NOC 10)." Washington, DC, Department of the Navy, June 2010. <http://www.navy.mil/maritime/noc/NOC2010.pdf>. (accessed December 8, 2011).

U.S. Department of the Navy. *Summary of the DoD Fiscal 2013 Budget Proposal*. Navy News Service. <http://www.defense.gov/news/2013budget.pdf>. (accessed February 14, 2012).

U.S. Department of the Navy. "USS Mesa Verde Completes Shock Trials." September 18, 2008. http://www.navy.mil/search/display.asp?story_id=39846. (accessed January 19, 2012).

U.S. Department of the Navy. *United States Navy Fact File: Joint High Speed Vessel – JHSV*, November 10, 2011. Accessed January 17, 2012. http://www.navy.mil/navydata/fact_display.asp?cid=4200&tid=1400&ct=4.

U.S. Department of the Navy. *United States Navy Fact File: Littoral Combat Ships – Mission Modules*, November 23, 2011. http://www.navy.mil/navydata/fact_display.asp?cid=2100&tid=406&ct=2. (accessed January 16, 2012).

U.S. Department of the Navy. *United States Navy Fact File: Littoral Combat Ship Class – LCS*, December 15, 2011. http://www.navy.mil/navydata/fact_display.asp?cid=4200&tid=1650&ct=4. (accessed December 8, 2011).

Official Navy fact file with specifications, features, and background on the LCS.

U.S. Department of the Navy, *United States Navy Fact File: Littoral Combat Ships- Anti-Submarine Warfare (ASW) Mission Package*, November 23, 2011. http://www.navy.mil/navydata/fact_display.asp?cid=2100&tid=412&ct=2. (accessed January 15, 2012).

U.S. Department of the Navy, *United States Navy Fact File: Remote Multi-Mission Vehicle – (RMMV)*. November 28, 2011. http://www.navy.mil/navydata/fact_display.asp?cid=2100&tid=453&ct=2. (accessed January 16, 2012).

U.S. Government Accountability Office. *Defense Acquisitions: Navy's Ability to Overcome Challenges Facing the Littoral Combat Ship Will Determine Eventual Capabilities*. Washington, DC: Government Accountability Office, August 2010. <http://www.gao.gov/new.items/d10523.pdf> (accessed January 15, 2012).

GAO report concerning cost growth and progress issues with mission modules in LCS.

U.S. Naval History & Heritage Command. "U.S. Navy Ships: Sunk & Damaged in Action during the Korean Conflict." <http://www.history.navy.mil/faqs/faq82-4.htm> (accessed February 15, 2012).

List of U.S. warships sunk in combat- to find the last ship that was sunk.

Wilson, Lindsay. "Lockheed Martin Achieves Critical Reliability Testing Milestone on U.S. Navy Minehunting System," *Lockheed Martin*. December 19, 2011. http://www.lockheedmartin.com/news/press_releases/2011/121911_LM_RMMV.html. (accessed January 16, 2012).

News release on the LCS mine hunting system milestone of 500 hours being surpassed.

Zaletski, Roy, LCDR, USN, OIC, HSC-22 Detachment TWO to Commanding Officer, H-60R/S Fleet Introduction Team. April 23, 2010. HSC-22 Det TWO/FREEDOM (GOLD) Early Deployment Lessons Learned.

Valuable information from the Officer in Charge of the aviation department that was on USS *Freedom's* Maiden deployment, GOLD crew. Lesson's Learned documents describe issues, problems, and possible solutions to them.

Bibliography- Secondary Sources

Cavas, Christopher P. "Despite Cuts, Navy shipbuilding gets priority." *Navy Times*, January 16, 2012. <http://www.navytimes.com/news/2012/01/navy-fleet-sean-stackley-shipbuilding-remains-priority-011612w> (accessed January 18, 2012).

Navy Times article reporting that with the defense cuts, shipbuilding will be mostly untouched.

Cavas, Christopher P. "LCS 1 Vs. 2: Both Meet the Requirements, But Similarities End There," *Defense News*, May 3, 2010. <http://www.defensenews.com/article/20100503/DEFSECT03/5030307/LCS-1-Vs-2-Both-Meet-Requirements-Similarities-End-There>. (accessed February 10, 2012).

Defense News article about the differences between the two classes of LCS.

Cebrowski, A. K., Vice Admiral USN and Captain Wayne P. Hughes, Jr., USN (Ret.), "Rebalancing the Fleet." *Proceedings*, (November 1999). <http://www.usni.org/magazines/proceedings/1999-11/rebalancing-fleet>. (accessed December 31, 2011).

Proceedings Article about the importance of littoral waters and rebalancing combat power with cheaper ships.

Defense Industry Daily. "The USA's DDG-1000 Zumwalt Class Program: Dead Aim, or Dead End?" January 3, 2012. <http://www.defenseindustrydaily.com/dead-aim-or-dead-end-the-usas-ddg1000-zumwalt-class-program-02574>. (accessed February 15, 2012).

Article on the status of the DD1000 program.

Defense Industry Daily. "The USA's New Littoral combat Ships (LCS)." December 19, 2011. <http://www.defenseindustrydaily.com/the-usas-new-littoral-combat-ships-updated-01343>. (accessed January 15, 2012).

In depth article on the status of the LCS program with excellent timeline.

Defense Industry Daily. "Spartan USVs for Singapore's Navy." May 18, 2005. <http://www.defenseindustrydaily.com/spartan-usvs-for-singapores-navy-0540> (accessed March 4, 2012).

Fuentes, Gidget. "New helo squadron will fly Fire Scouts, too." *Navy Times*, November 27, 2011. <http://www.navytimes.com/news/2011/11/navy-new-helicopter-squadron-will-fly-fire-scouts-112711w>. (accessed January 14, 2012).

Navy Times article reporting that HSM (MH-60R) squadrons will deploy with a fly MQ-8B Fire Scouts.

Gresham, John D. "USS Freedom (LCS 1) Deploys," *Defense media network*. February 19, 2010. <http://www.defensemedianetwork.com/stories/uss-freedom-lcs-1-deploys>, (accessed January 18, 2012).

Article about USS *Freedom*'s Maiden deployment.

Handley, Edmund J, LT, USN. "US Navy Littoral Combat Ship (LCS) Capabilities, Risks, Possible Missions, and Modules to Support Future USMC Operating Concepts." Master's thesis, Marine Corps University, 2010. <http://65.114.145.226/isysquery/9b9d8ab8-1e7e-4755-a118-febd00a30f77/3/doc/>. (accessed November 20, 2011).

2010 MMS on LCS capabilities, missions, and mission modules. Great overall source on LCS information, but focuses on design specs and promised mission capabilities, nor current status. Good reference to find sources to conduct my own research.

Jean, Grace V, "Duty aboard the Littoral Combat Ship: 'Grueling but Manageable'", September 2010. <http://www.nationaldefensemagazine.org/archive/2010/September/Pages/DutyAboardtheLittoralCombatShip%E2%80%98GruelingbutManageable%E2%80%99.aspx>. (accessed February 10, 2012).

Article with crew interviews on crew size and workload.

Johnson, Jay L. Admiral, USN, "Numbers Do Matter." *Proceedings* (November 1999). <http://www.unsi.org/magazines/proceedings/1999-11/rebalancing-fleet>. (accessed December 31, 2011).

Article about numbers of ships- what mix and how many of each type will be needed in the future.

Lerman, David and Tony Capaccio. "Navy Finds 'Aggressive' Corrosion on New Ship" *Bloomberg* (June 17, 2011). <http://www.bloomberg.com/news/2011-06-17/navy-finds-aggressive-corrosion-on-austal-s-combat-ship-1-.html> (accessed January 19, 2012).

Report on corrosion in LCS-2.

Lundquist, Edward “Lessons Learned Lead to Improvements in Follow-on LCS Ships.” *MarinLink.com* (December 5, 2011). <http://www.marinelink.com/news/improvements-littoral341595.aspx> (accessed January 19, 2012).

Article reporting on the deficiencies of each early LCS and how they will be fixed in follow on ships.

Long, Duncan and Stuart Johnson, “The Littoral Combat Ship: From Concept to Program.” *Case Studies in National Security Transformation No. 7*, March 2007. <http://www.ndu.edu/CTNSP/docUploaded/case%207%20LCS.pdf> (accessed December 31, 2011).

Center for Technology and National Security Policy prepared case study in which had great cited information on the birth of the LCS ship and lead me to find other sources such as the Proceedings articles used for this paper.

“Littoral Combat Ship (LCS), United States of America.” <http://www.naval-technology.com/projects/littoral>. (accessed January 12, 2012).

Technical specifications of the LCS.

McCarthy, Mike. “DoD Proposes Smaller FY 2013 Shipbuilding Budget,” *Defense Daily*, February 14, 2012. http://www.defensedaily.com/free/DoD-Proposes-Smaller-FY-2013-Shipbuilding-Budget_16745.html (accessed March 4, 2012).

“MH-60S Seahawk (Knighthawk), United States of America.” http://www.naval-technology.com/projects/mh_60s. (accessed January 18, 2012).

Technical information on the MH-60S helicopter.

Mortimer, Gary. “Northrop Grumman Fire Scout completes Successful At-Sea Deployment.” *SUAS News*, August 17, 2011. <http://www.suasnews.com/2011/08/6552/northrop-grumman-fire-scout-completes-successful-at-sea-deployment> (accessed January 14, 2012).

Information on the first MQ-8B Fire Scout deployment.

Murtaugh, Dan. “Austal gets \$322M for the next two JHSVs,” *al.com*, February 24, 2012. http://blog.al.com/live/2012/02/austal_gets_322m_for_next_two.html (accessed March 4, 2012).

Naval Mine Warfare. “US halts RAMICS.” May 31, 2011. <http://www.navalminewarfare.com/index.php/countries/43-united-states/109-us-halts-ramids>. (accessed February 10, 2012).

Story on the program cancellation of RAMICS.

Simms, Claire, “Hybrid Sailors Staff USS Independence.” *First Coast News*, November 9 2011. <http://origin.firstcoastnews.com/news/military/article/225986/162/Hybrid-Sailors-Staff-USS-Independence>. (accessed February 10, 2012).

News article highlighting how hard the crews have to work on LCS.

Witlock Chad. "Obama's Asia strategy gives Navy key role, fewer ships," *The Washington Post*, February 15, 2012. http://www.washingtonpost.com/world/national-security/obamas-asia-strategy-gives-navy-key-role-fewer-ships/2012/02/15/gIAhnNgGR_story.html (accessed March 4, 2012).

Article on LCS ships being stationed in Singapore and using three crews per two ships.